

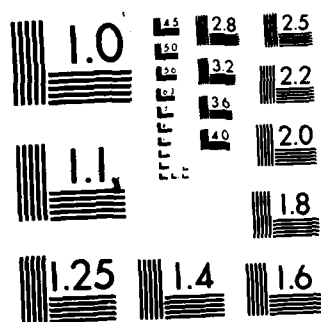
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**Environmental Qualification Tests,  
Signal Conditioning Unit,  
SD802 Materials Experiment**

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and  
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**Materials Sciences Laboratory  
Laboratory Operations  
The Aerospace Corporation  
El Segundo, Calif. 90245**

**1 December 1983**

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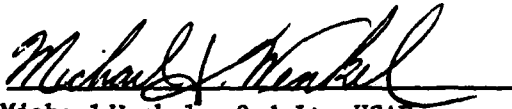
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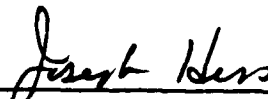
This report was submitted by The Aerospace Corporation, El Segundo, CA 90245, under Contract No. F04701-83-C-0084 with the Space Division, Deputy for Technology, P.O. Box 92960, Worldway Postal Center, Los Angeles, CA 90009. It was reviewed and approved for The Aerospace Corporation by L. M. McCreight, Director, Materials Sciences Laboratory. Second Lieutenant Michael Wenkel, SD/YC, was the project officer for the Mission-Oriented Investigation and Experimentation (MOIE) Program.

This report has been reviewed by the Public Affairs Office (PAS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.




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Project Officer



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The vibration qualification test described within this report completes the vibration qualification requirements as established by the LDEF Project Office for flight hardware associated with the SD802 materials experiment. The combined environment temperature altitude test described was completed to establish the operating stability of electronic components within the signal conditioning electronics units (SCUs). 		

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## I. TEST DESCRIPTION

### A. TEST OBJECTIVES

#### 1. VIBRATION QUALIFICATION TESTS

Vibration tests were performed at qualification test levels to expose any vibration detectable faults residing in electronics piece parts and weakness in bonds or wires making the internal connections.

#### 2. COMBINED TEMPERATURE - ALTITUDE TESTING

The combined temperature altitude testing was necessary to test the operating stability of the signal conditioning electronic packages at ambient, upper, and lower temperatures while simulating the flight altitude. The temperature cycling also provided the following:

- a. Significant stressing of solder joint connections
- b. Established the integrity of the design
- c. Provided assurance of component reliability

### B. TEST PACKAGE DESCRIPTION

The flight signal conditioning electronics packages are duplicate units, SN 001 and SN 002, which will be flown on the leading and trailing edge of the Long Duration Exposure Facility (LDEF) Spacecraft. A photograph, which presents an overview of the internal configuration of the electronics package, is shown in Fig. 1.

The signal conditioning units (SCUs) were designed to provide the interface electronics between transducers, which include strain gages, thermistors, solar cell outputs and quartz crystal microbalance, and the data recording system. A SD/LDEF Technical Users' Manual has been published and provides a complete review of the flight and ground support electronics, programming, qualification testing, and transducer location.<sup>1</sup>

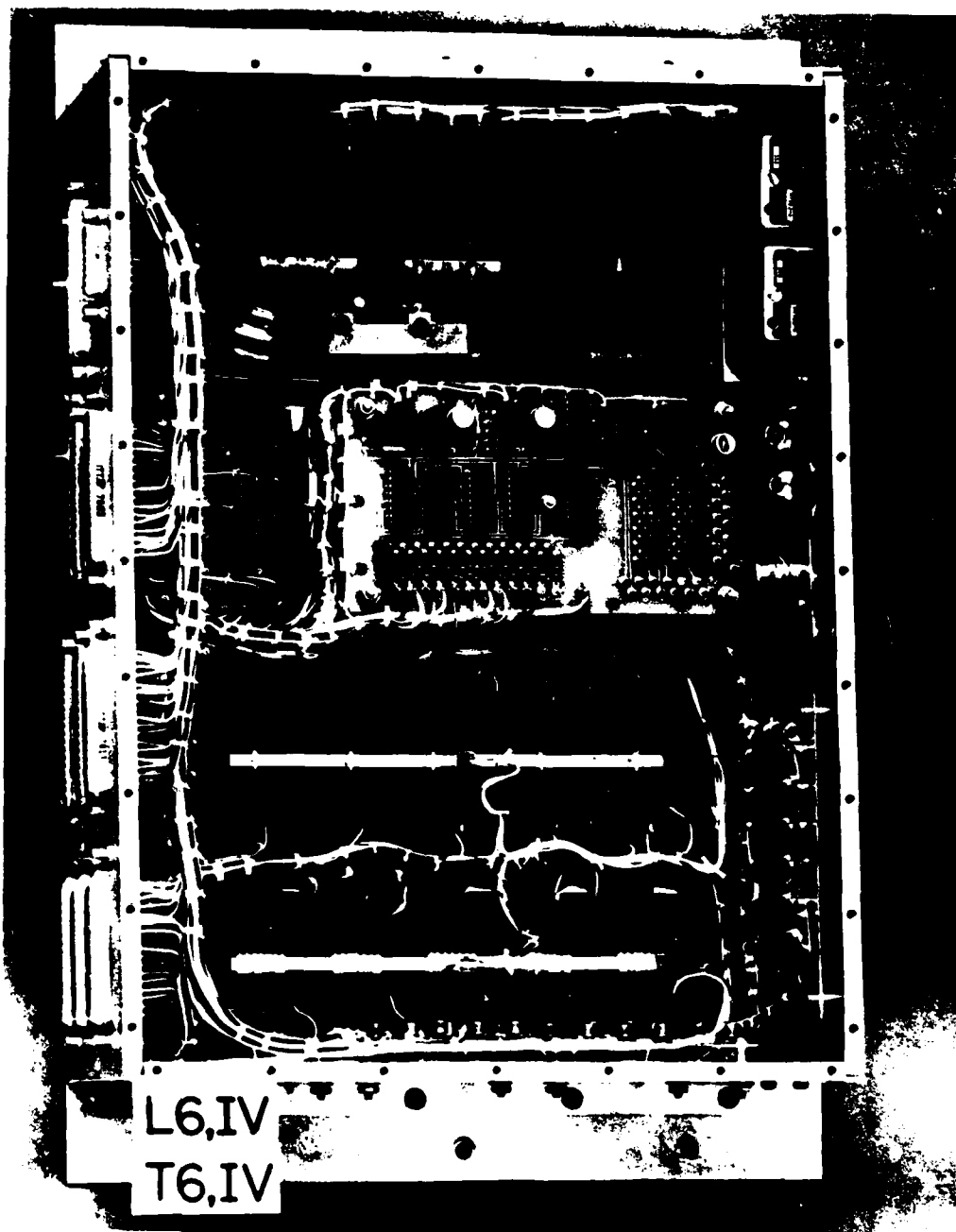


Fig. 1. Signal Conditioning Unit, Internal Electronics Assembly

## II. VIBRATION - TEST SPECIFICATIONS AND EQUIPMENT DESCRIPTION

### A. BACKGROUND

The vibration tests described herein were conducted for Aerospace by Approved Engineering Test Laboratories (AETL), Los Angeles, California. The test plan provided to AETL followed the qualification test specifications as described by the test procedures drafted by C. Kiser of NASA Langley Research Center. A copy of these procedures is on file at The Aerospace Corporation, Materials Sciences Laboratory.<sup>2-4</sup> Previous qualification tests conducted on SD802 flight hardware are documented in Ref. 5. The test report from AETL is given in Ref. 6.

### B. TEST SPECIFICATIONS

Test specifications were as follows:

1. Sine survey: 5 to 2000 Hz at 0.5 g peak
2. Sine qualification:

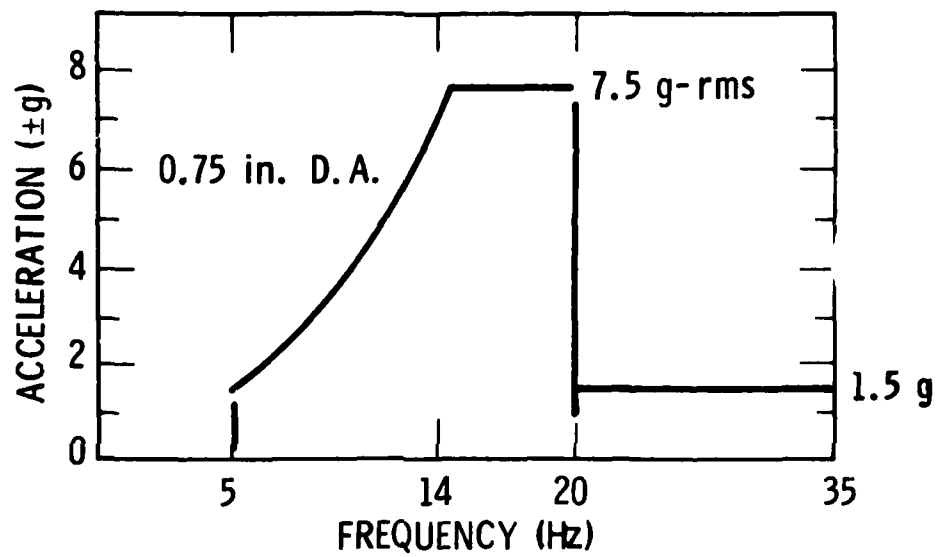
<u>Input Amplitude</u>	<u>Frequency Range (Hz)</u>	<u>Sweep Rate</u>
0.75 in., D.A.	5 to 14	2 oct/min
7.5 $\pm$ g rms	14 to 20	2 oct/min
1.5 $\pm$ g rms	20 to 35	2 oct/min

Test specifications are shown in Fig. 2.

3. Random vibration qualification test input:

<u>Frequency (Hz)</u>	<u>Intensity</u>
20 to 60	6 dB/octave rise
60 to 300	0.225 g <sup>2</sup> /Hz
300 to 2000	6 dB/octave rolloff

Overall acceleration was 10.9 g rms, and the test duration was 60 sec. These results are shown in Fig. 3.



DURATION = 2 oct/min, 5 to 35 Hz

Fig. 2. Sinusoidal Vibration Conditions for Qualification Tests

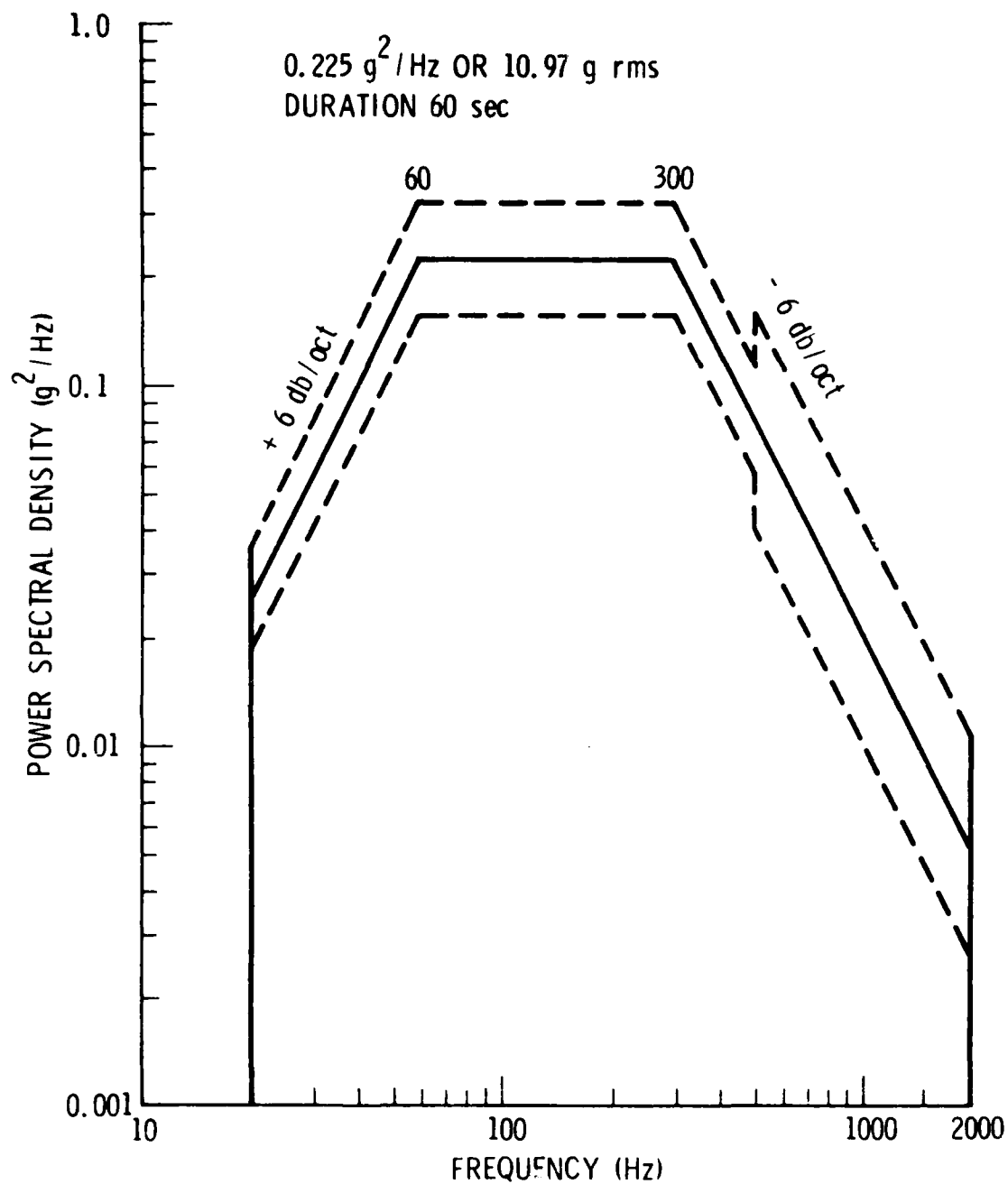


Fig. 3 Random Vibration Conditions for Qualification Tests

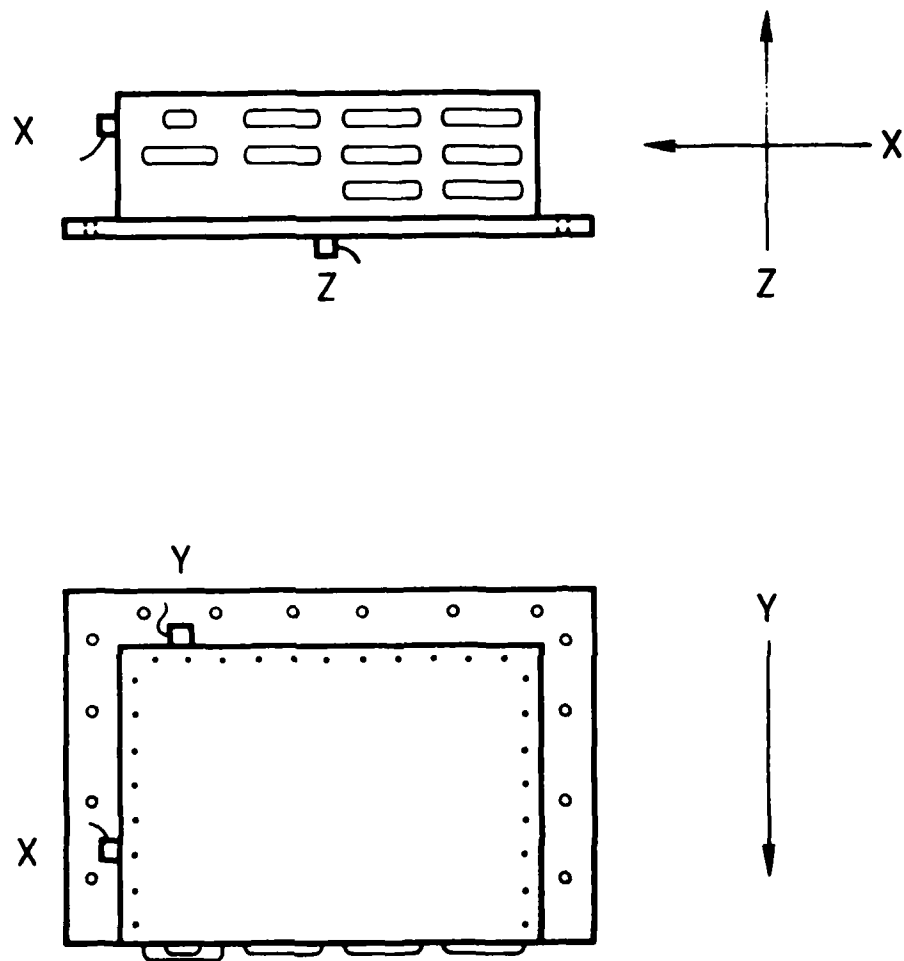
C. DOCUMENTATION

To validate that the qualification test conditions were adhered to, the response of sinusoidal and random vibration input control or monitor accelerometers are presented. In Fig. 4 the relative position of the monitor accelerometers is shown. The accelerometer response traces are depicted in Figs. 5 through 17. A single input control accelerometer was used for both the sine and random vibration tests.

D. EQUIPMENT DESCRIPTION

<u>AETL No.</u>	<u>Manufacturer</u>	<u>Instrument</u>
D85L	M. B. Electronics	Amplifier, M/N T996
D86L	Hewlett Packard	Oscilloscope, M/N 122AR
D169L	Spectral Dynamics	Sweep Oscillator Servo, M/N SD 114
D170L	Spectral Dynamics	Automatic Level Programmer, M/N SD 117
D186L	Ampex Corporation	Tape Recorder, M/N RF1100/ES100
D222L	M. B. Electronics	Vibration Exciter, M/N C126
D250L	Endevco Corporation	Accelerometer, M/N 2213
D458L	Endevco Corporation	Accelerometer, M/N 2226C
D465L	Spectral Dynamics	Automatic Random Digital System, M/N SD1009A
D482L	Unholtz Dickie	Charge Amplifier, M/N D22PMSLOT
D486L	Unholtz Dickie	Charge Amplifier, M/N D22PMSLT
D487L	Unholtz Dickie	Charge Amplifier, M/N D22PMSLT
D492L	Endevco Corporation	Accelerometer, M/N 2226C
D494L	Endevco Corporation	Accelerometer, M/N 2213
D511L	Hewlett Packard	Logarithmic Voltmeter/Converter, M/N 7562A
D563L	Hewlett Packard	X-Y Recorder, M/N 7010B
E364L	Ballantine Laboratories	Spectral Density Voltmeter, M/N 320A-U10

NOTE: The test equipment specified above was calibrated, as required, in accordance with MIL-C-45662A, with traceability to the National Bureau of Standards (NBS). The NBS traceability records are on file in the National Testing Services Co./Testing Division Quality Control Office.



**Fig. 4. Accelerometer Location and Vibration Axis Designation**



TEST ITEM	SIGNAL COND
PART No.	Te
SERIAL No.	002
DATE	5-29-81
INPUT LEVEL	7.5 g's
ACCELEROMETER No.	CONTROL REPRESENTATIVE
	CONTROL PLOT
AXIS	X
LOCATION	ON FIXTURE

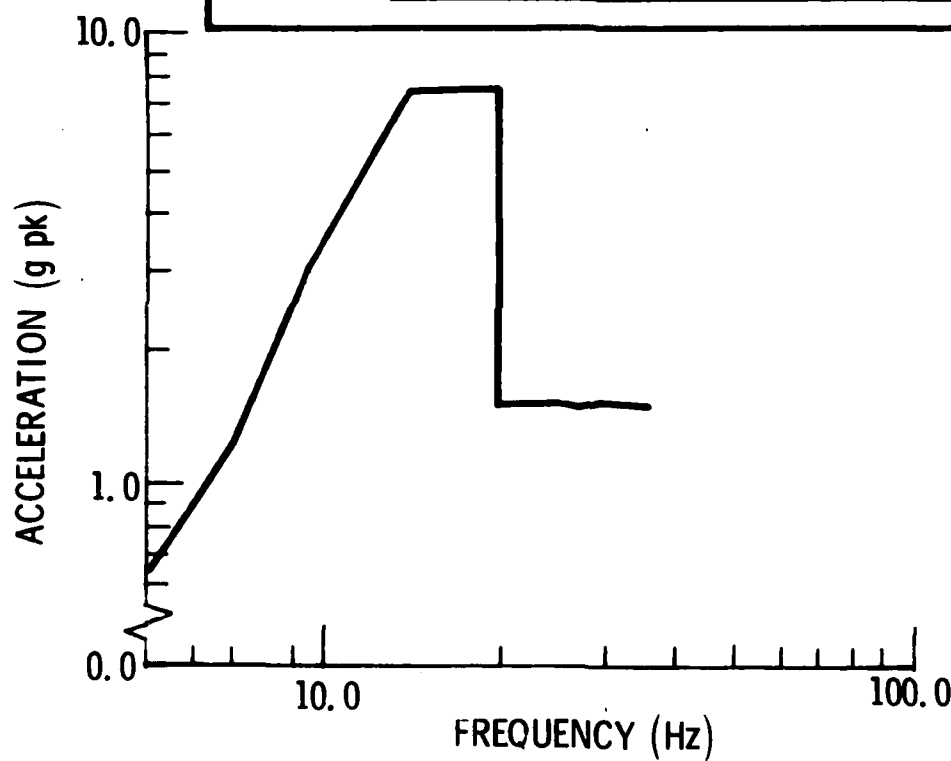


Fig. 5. Signal Conditioning Unit SN 002, Sine Vibration Representative Input Control Accelerometer

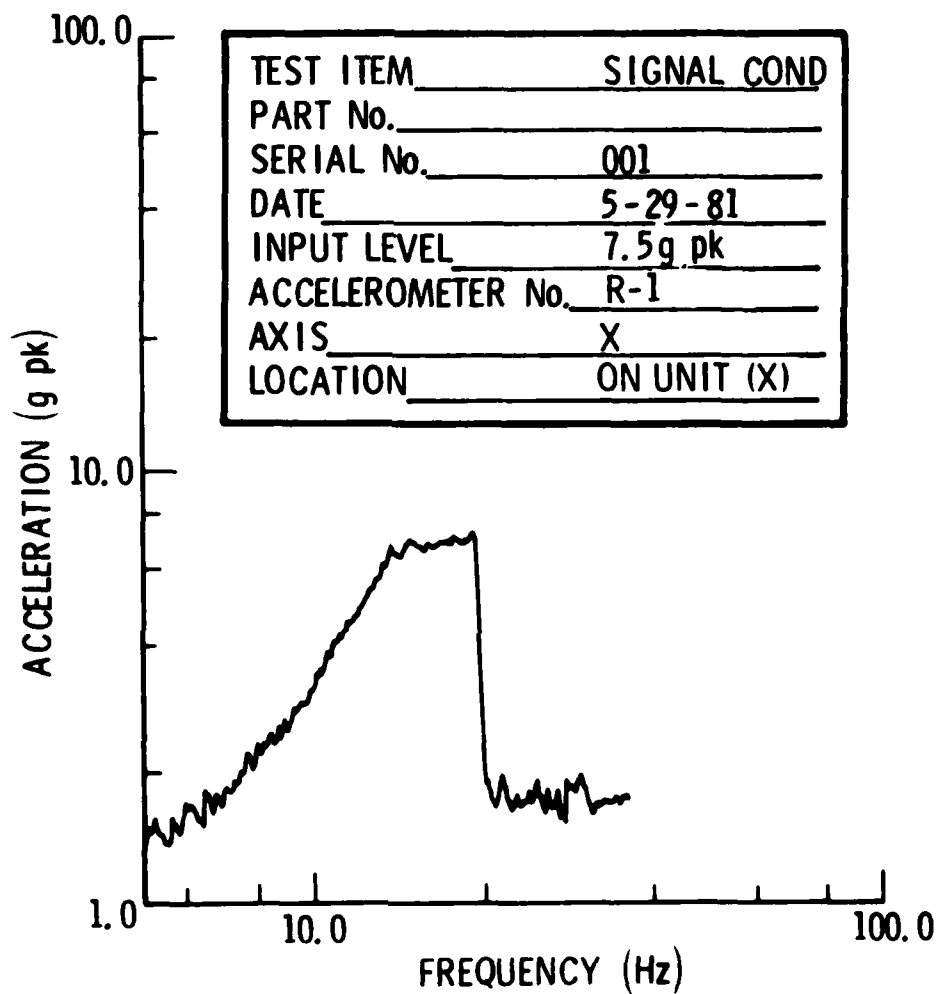


Fig. 6. Signal Conditioning Unit SN 001, Sine Vibration, Monitor Accelerometer, X Axis

TEST ITEM	SIGNAL COND
PART No.	
SERIAL No.	001
DATE	5-29-81
INPUT LEVEL	7.5g pk
ACCELEROMETER No.	R-2
AXIS	Y
LOCATION	ON UNIT (Y)

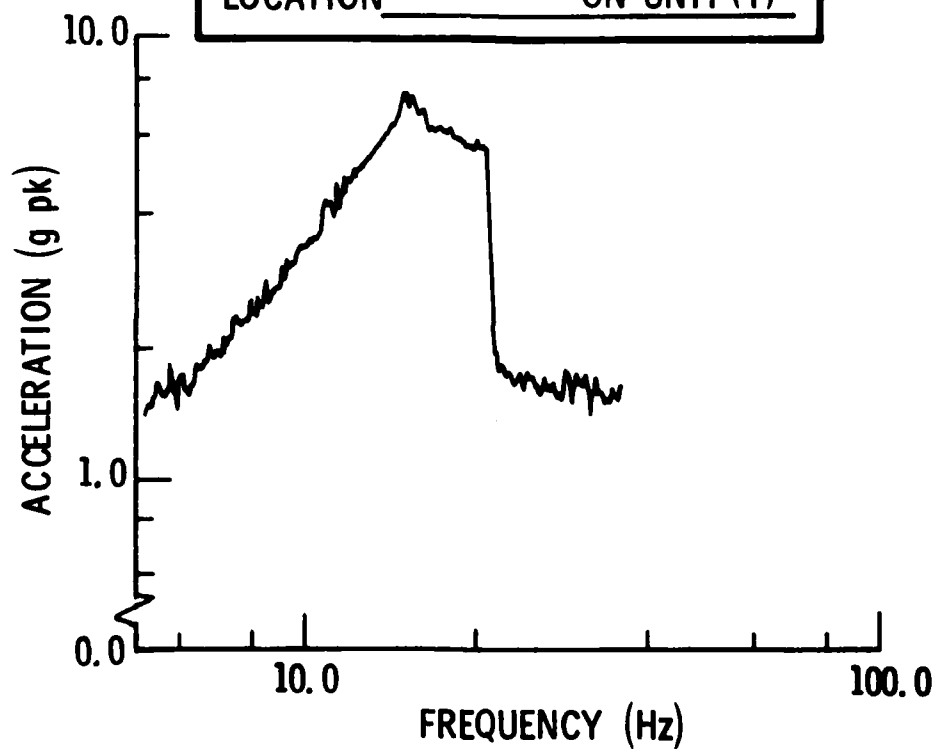


Fig. 7. Signal Conditioning Unit SN 001, Sine Vibration, Monitor Accelerometer, Y Axis

TEST ITEM	SIGNAL COND
PART No.	
SERIAL No.	001
DATE	5-29-81
INPUT LEVEL	7.5g pk
ACCELEROMETER No.	R-3
AXIS	Z
LOCATION	ON UNIT (Z)

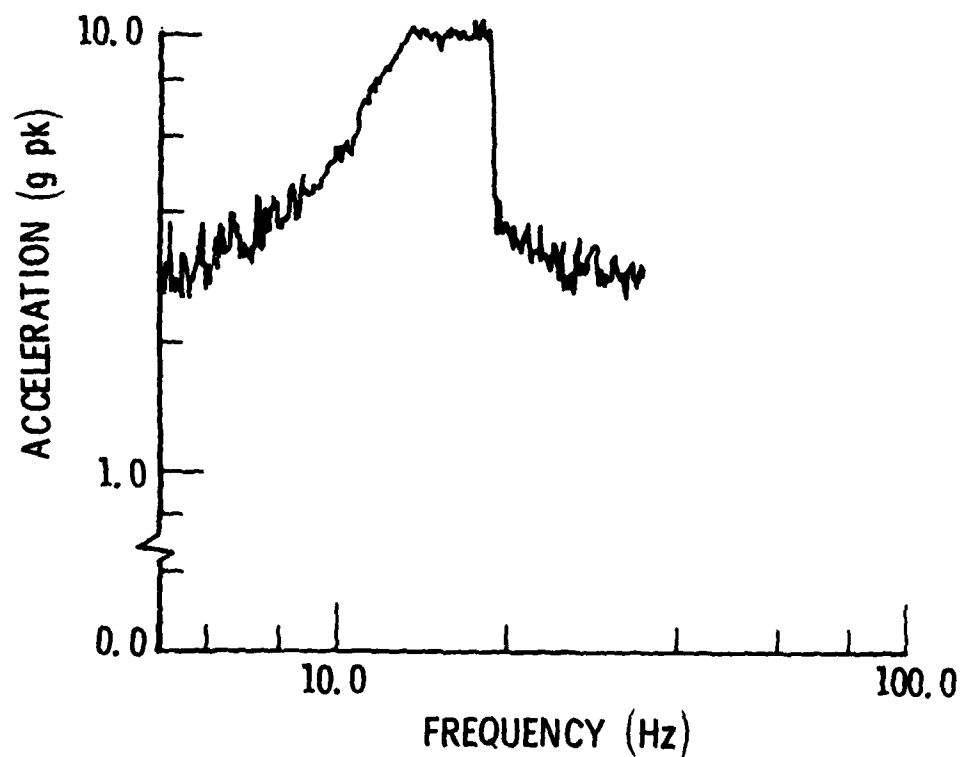


Fig. 8. Signal Conditioning Unit SN 001, Sine Vibration, Monitor Accelerometer, Z Axis

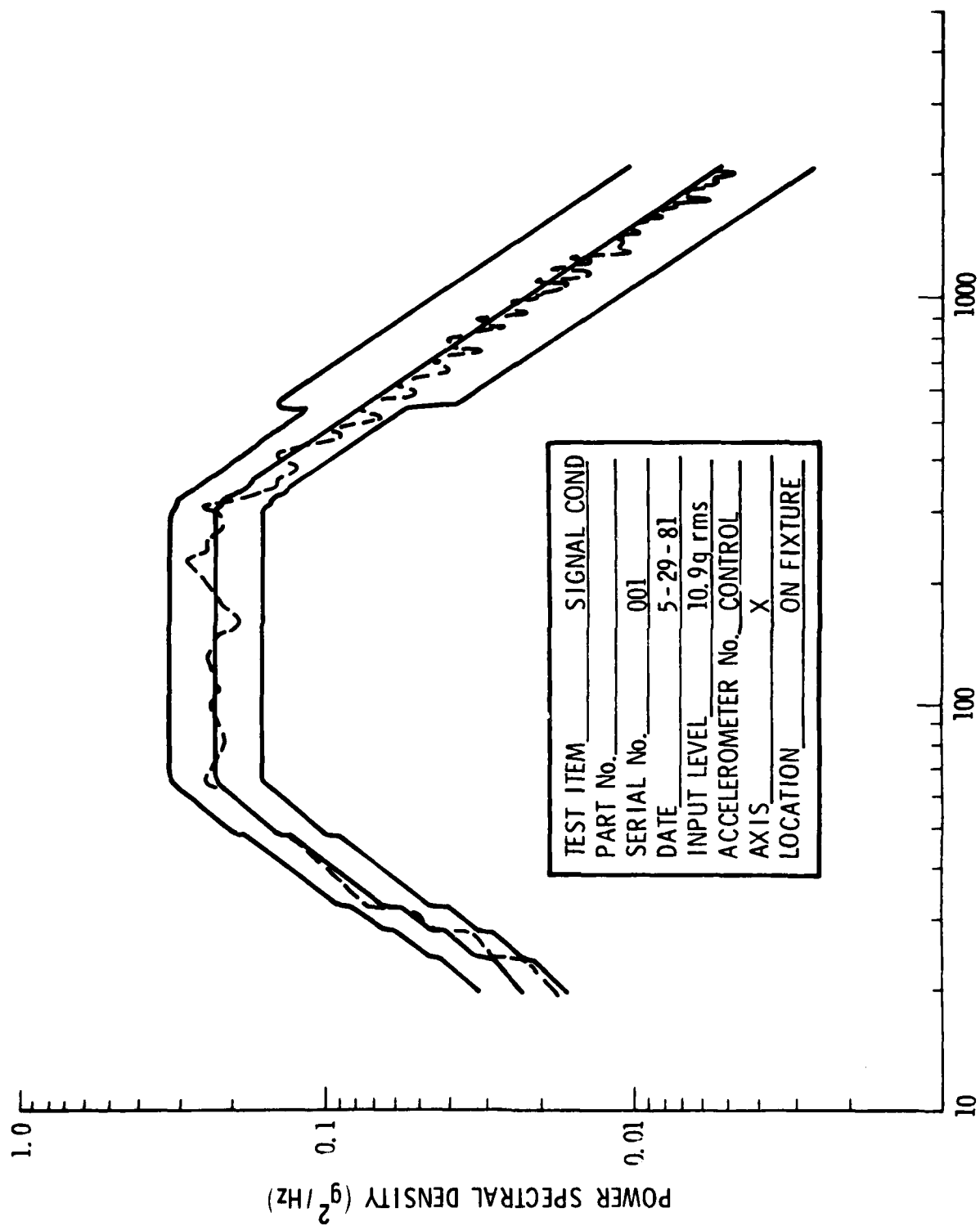


Fig. 9. Signal Conditioning Unit, SN 001, Input Control Accelerometer, X Axis

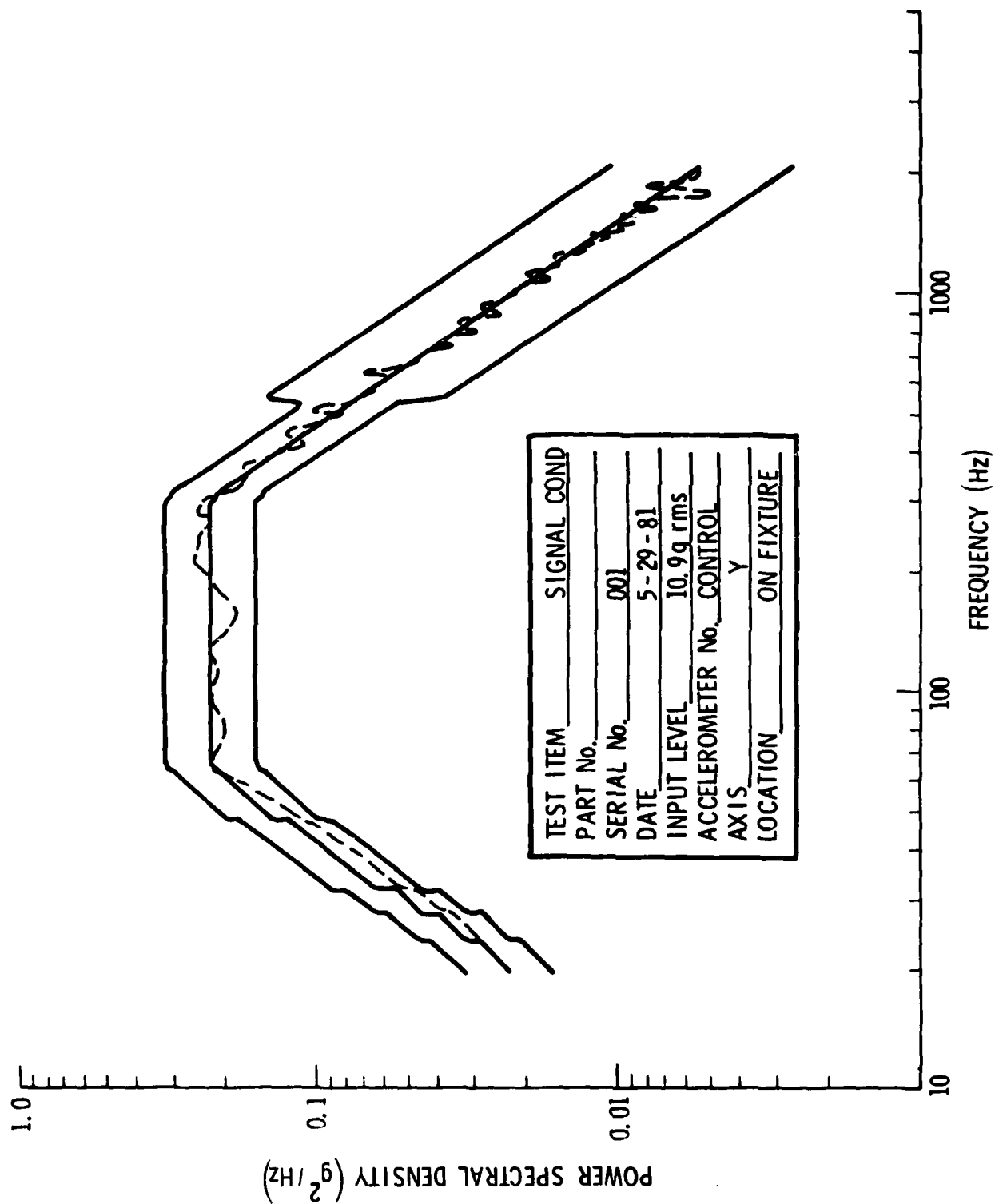


Fig. 10. Signal Conditioning Unit, SN 001, Random Vibration Input  
Control Accelerometer, Y Axis

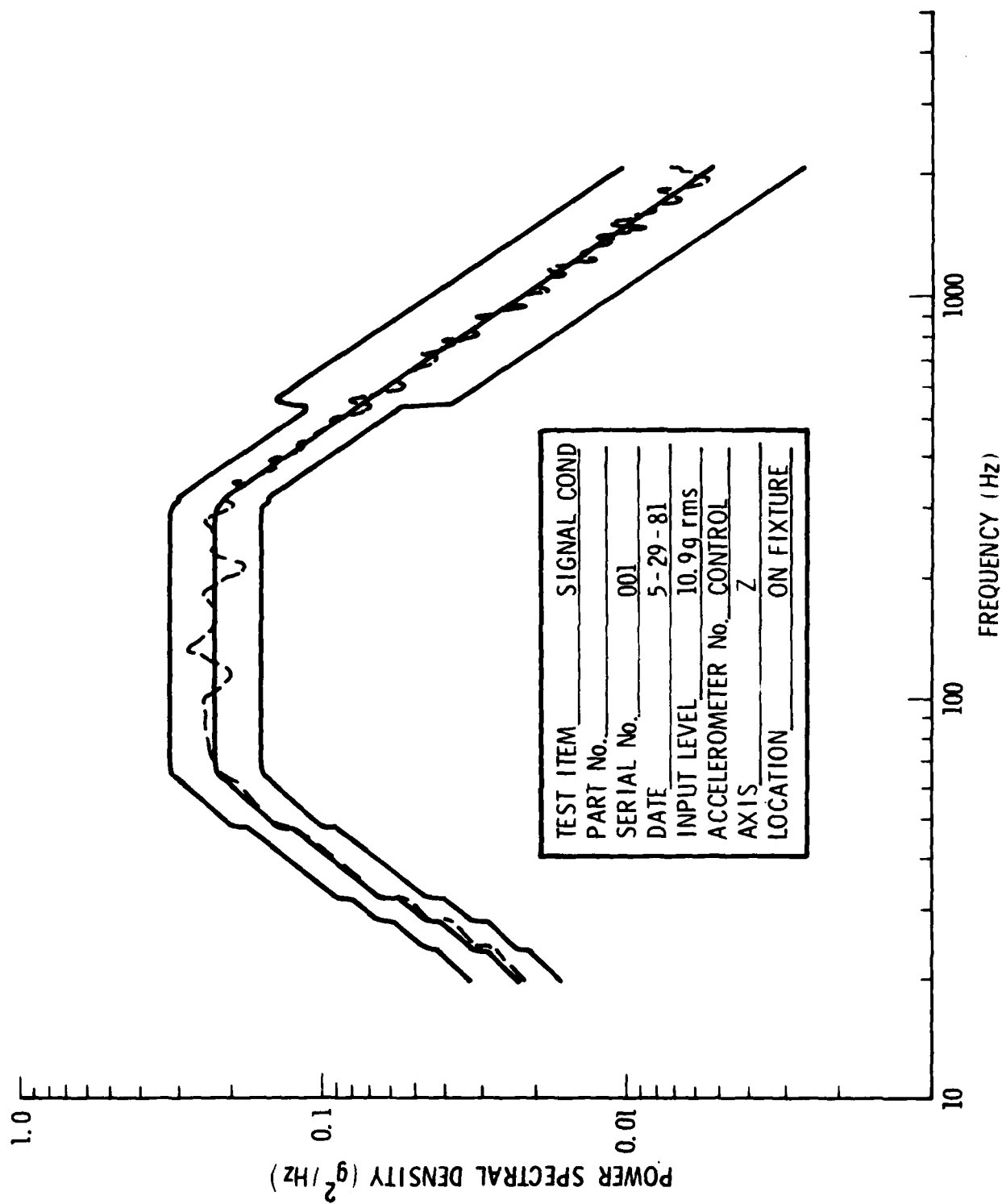


Fig. 11. Signal Conditioning Unit, SN 001, Random Vibration Input  
Control Accelerometer, Z Axis

TEST ITEM	SIGNAL COND
PART No.	
SERIAL No.	002
DATE	5-29-81
INPUT LEVEL	7.5 g's
ACCELEROMETER No.	R-1
AXIS	X
LOCATION	ON UNIT(X)

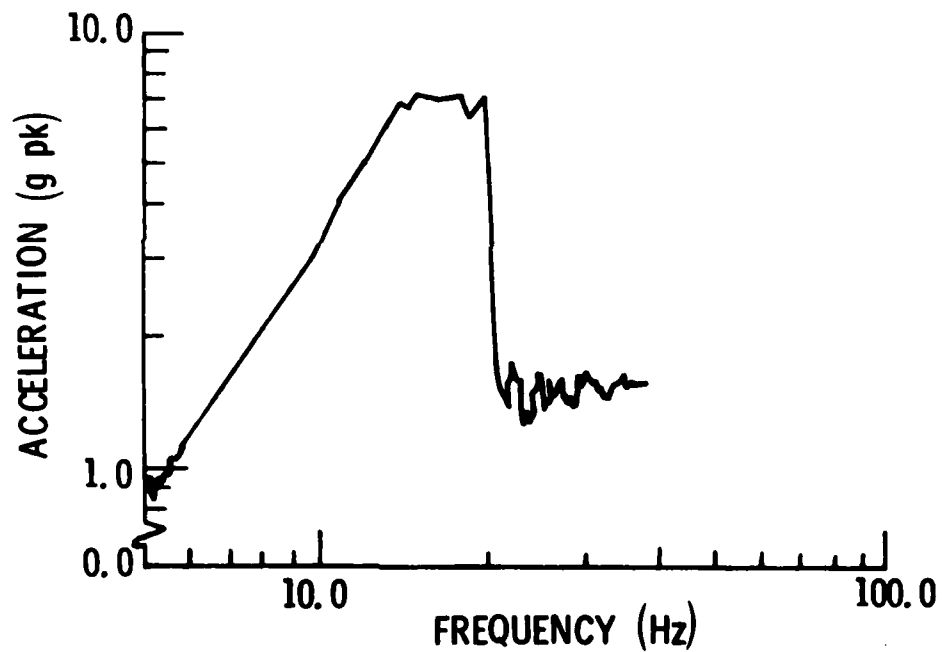


Fig. 12. Signal Conditioning Unit, SN 002, Sine Vibration, Monitor Accelerometer, X Axis



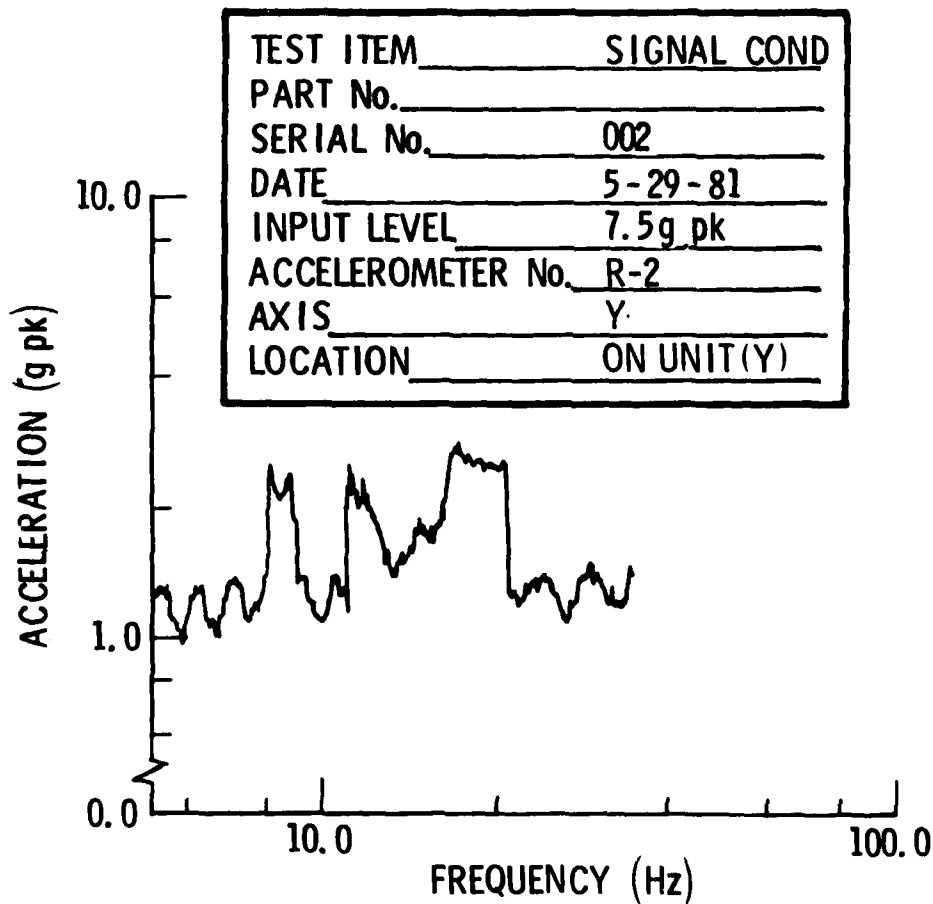


Fig. 13. Signal Conditioning Unit, SN 002, Sine Vibration, Monitor Accelerometer, Y Axis

TEST ITEM	SIGNAL COND
PART No.	
SERIAL No.	002
DATE	5-29-81
INPUT LEVEL	7.5g pk
ACCELEROMETER No.	R-3
AXIS	Z
LOCATION	ON UNIT (Z)

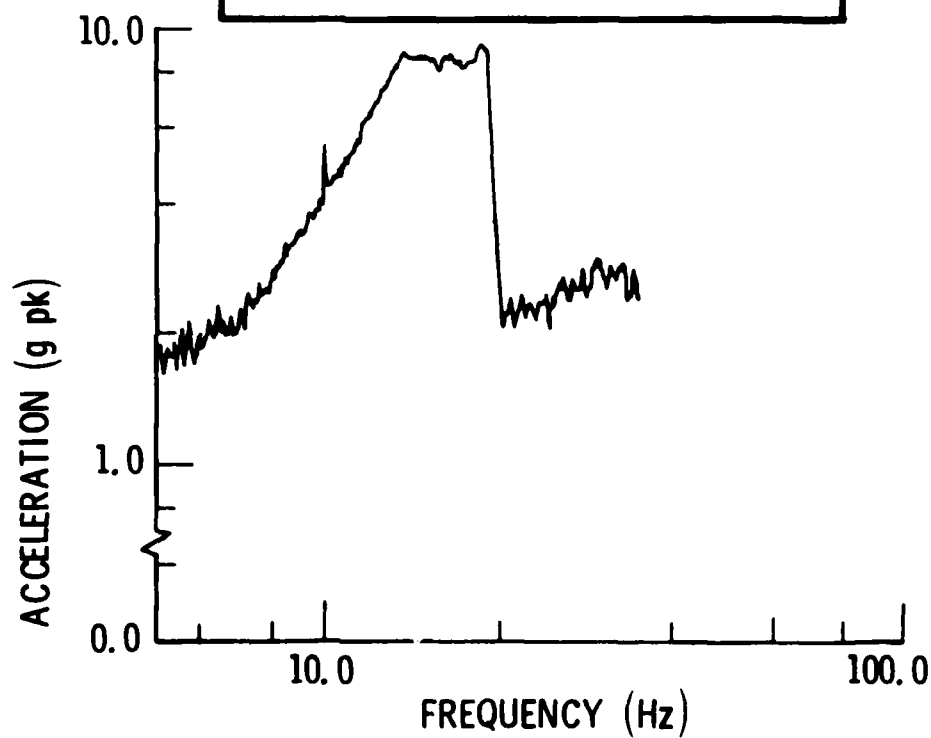


Fig. 14. Signal Conditioning Unit, SN 002, Sine Vibration, Monitor Accelerometer, Z Axis

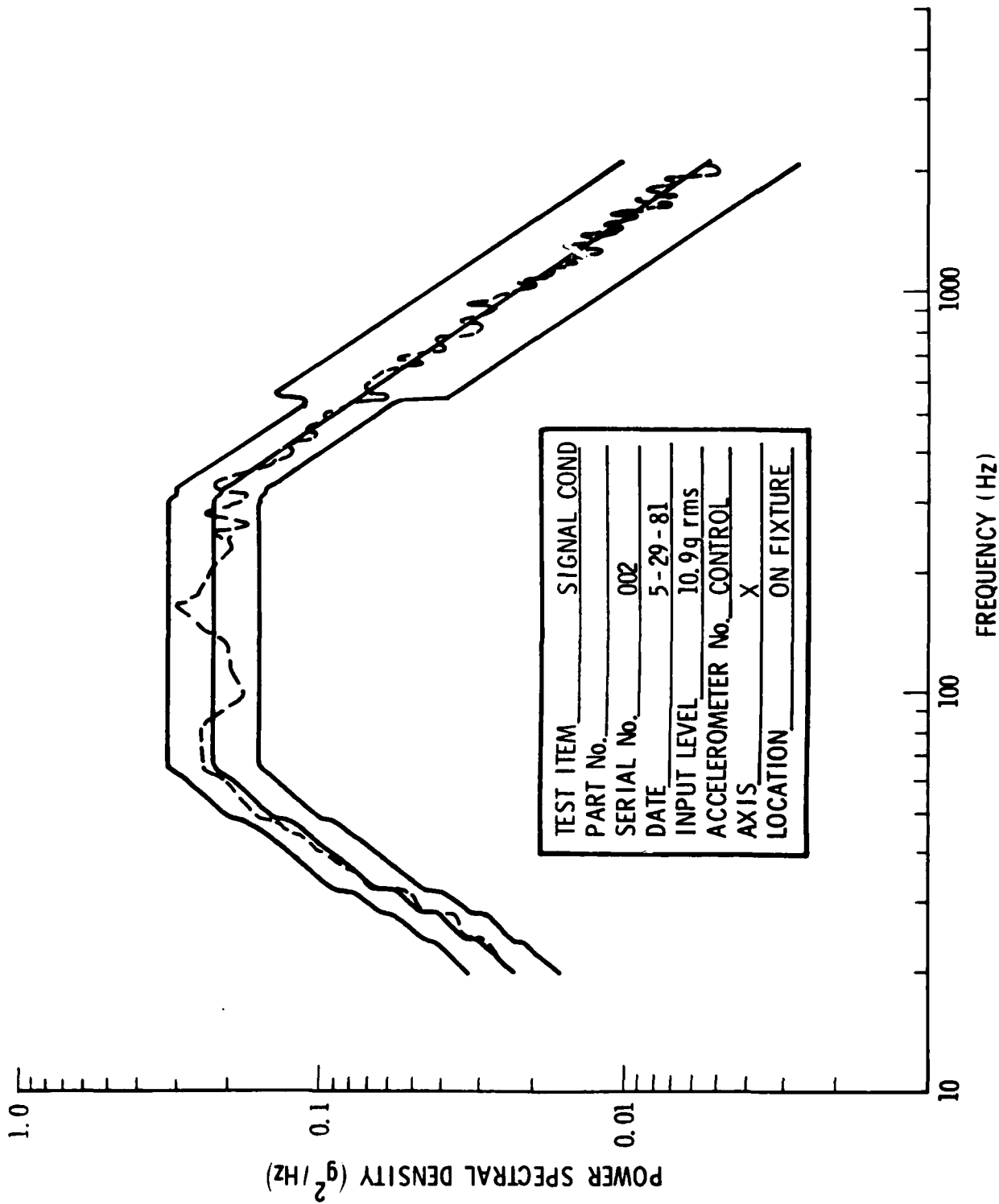


Fig. 15. Signal Conditioning Unit, SN 002, Random Vibration, Control Accelerometer, X Axis

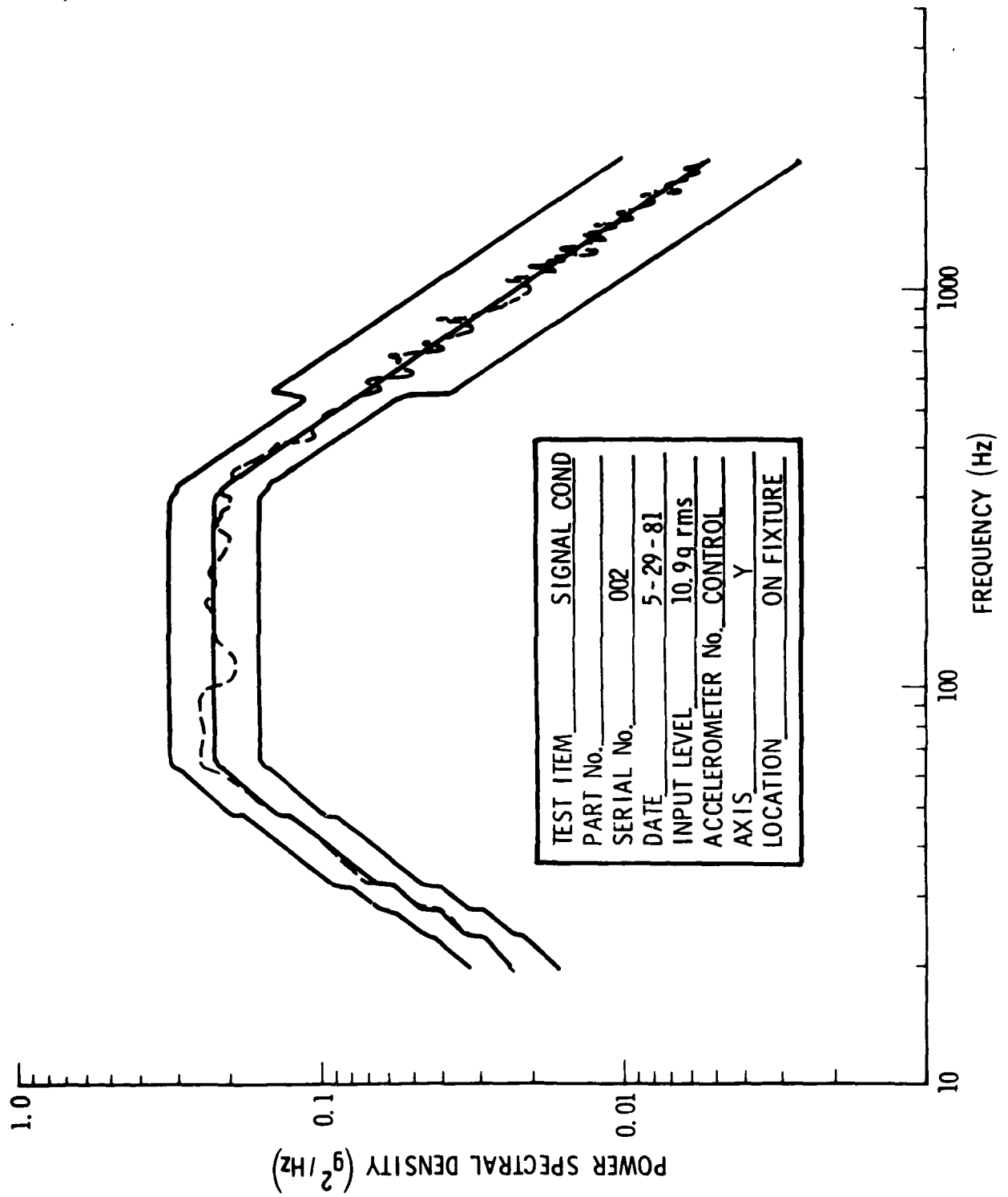


Fig. 16. Signal Conditioning Unit, SN 002, Random Vibration, Control Accelerometer, Y Axis

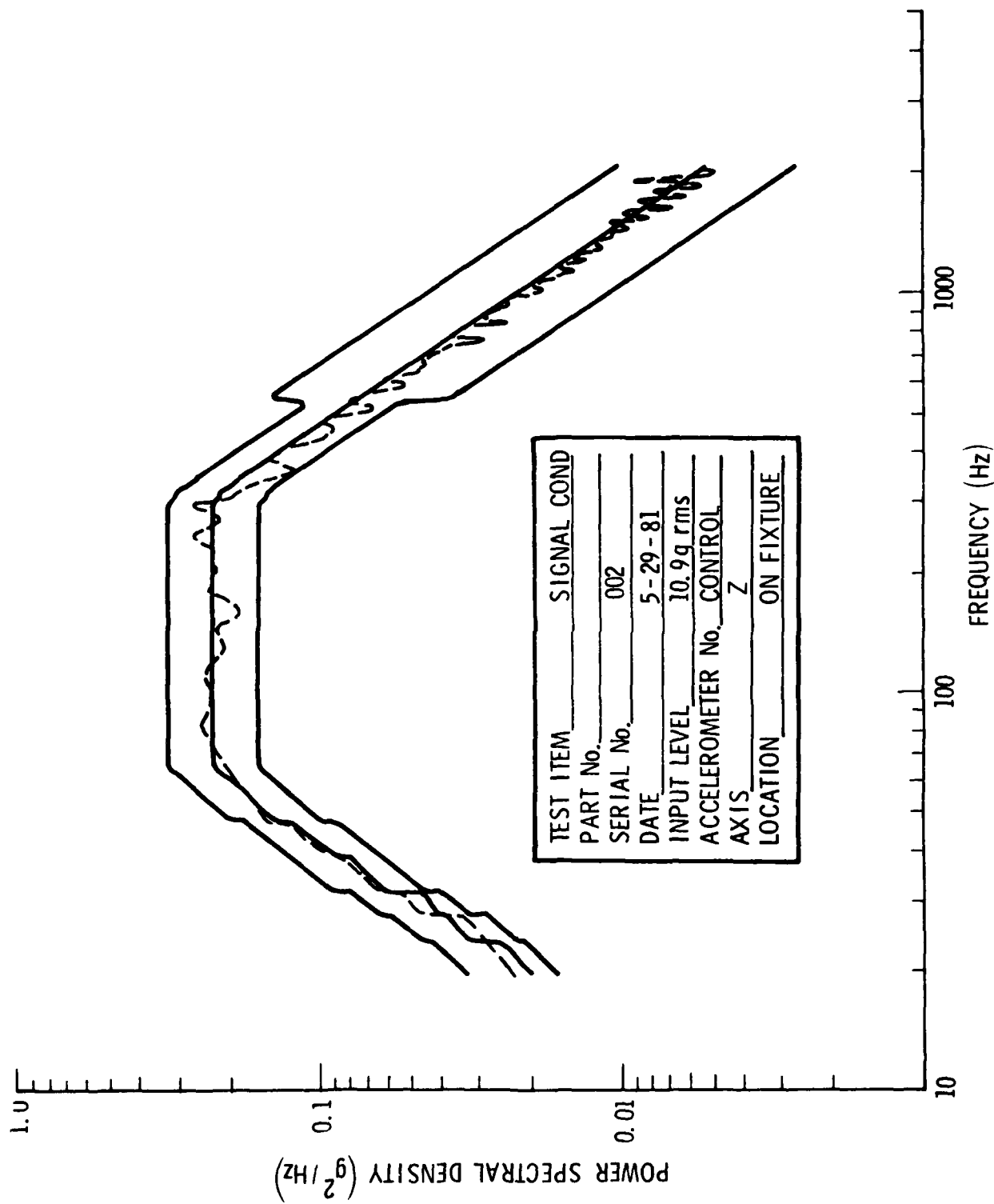


Fig. 17. Signal Conditioning Unit, SN 002, Random Vibration, Control Accelerometer, Z Axis

## E. TEST RESULTS

### 1. QUALIFICATION VIBRATION TESTS

Both units were subjected to the prescribed vibration tests as described in Section II.B. Electrical performance tests were conducted and documented prior to the qualification vibration tests. An electrical performance test was not conducted during or between the axial vibration tests, only after the completion of these tests. A monitor accelerometer was attached to each of the three mutually perpendicular axes of vibration; response data was recorded during each vibration test. A test unit mounted on the vibration exciter, Z axis, is shown in Fig. 18.

#### 2. SIGNAL CONDITIONING PACKAGE, SN 001

- a. The sinusoidal vibration sweep record for each axis showed that the lowest fundamental mode of vibration was recorded by the Z axis monitor accelerometer during the vibration survey of the Z axis. This resonant frequency occurred at 138 Hz, with a Q of 4.3.
- b. After completing vibration, a visual examination of the test unit was conducted. No internal or external physical damage was observed.
- c. The posttest electrical performance test revealed one broken wire at connector J-10 pin No. 17.

#### 3. SIGNAL CONDITIONING PACKAGE, SN 002

- a. The sinusoidal vibration sweep record for each axis showed that the lowest fundamental mode of vibration was recorded by the Z axis monitor accelerometer during the vibration survey of the Z axis. This resonant frequency occurred at 145 Hz, with a Q of 5.2.
- b. After completing vibration, a visual examination of the test unit was conducted. No internal or external physical damage was observed.
- c. The posttest electrical performance data were comparable to the recorded pretest data.

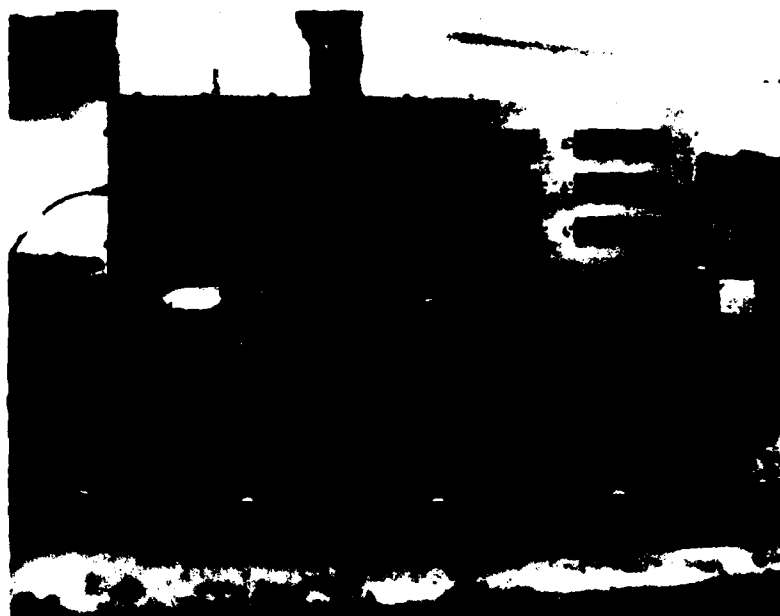


Fig. 18. Signal Conditioning Unit, SN 002, Mounted in the Z Axis  
on the Vibration Exciter

### III. COMBINED VACUUM TEMPERATURE TESTING - TEST PARAMETERS AND EQUIPMENT DESCRIPTION

#### A. BACKGROUND

Thermal models for each SCU were developed, and the thermal analysis was conducted using the boundary temperatures and radiant flux data pertaining to the planned orbital configuration.<sup>7</sup> The orbital conditions used to establish the range of test temperatures were those described in Ref. 7 as worst case hot and worst case cold. Temperature of the circuit boards and associated hardware which comprise the SCUs have been obtained by thermal modeling. Data obtained from both Refs. 7 and 8 are presented in Table 1.

The SCU assembly consists of an inner cover that directly shields the electronics and an external thermal cover. The external thermal cover was omitted for testing purposes. The units are not required to operate during ascent or descent; therefore, all test data were documented after the units were stabilized at the designated temperature and maximum attainable vacuum.

#### B. TEST PROCEDURE

The test unit was installed within the environmental chamber, and a readiness functional test was performed. The chamber pressure was different for each electrical function test recorded. The approximate pressure at which the high temperature data were recorded was  $4.5 \times 10^{-5}$  Torr, and the approximate pressure at which the low temperature data were recorded was  $1.5 \times 10^{-5}$  Torr.

Six thermal sensors for each unit were used to monitor the temperature. Four thermocouples were used to monitor the external temperature gradient across the housing; see Fig. 19. Two thermistors are attached to separate heat sinks that monitored the thermal response of the strain gage operational amplifiers. The output of the thermistors is one of the flight measurement tasks and will be recorded on data channels 51 and 52, identified as V TEMP 1 and V TEMP 2. The thermistors and heat sinks are visible in the bottom third of Fig. 1.



Table 1. Thermal Reference Material

LDEF Tray Experiment Environment <sup>1</sup>		
	Hot Case (°F)	Cold Case (°F)
Structure temperature	150	-10
Internal temperature (radiative heat sink)	120	10
Temperature Extremes <sup>2</sup>		
Module IV, Tray Position D4 and D8		
Location	Worst Case Maximum Temperature (°F)	Worst Case Minimum Temperature (°F)
Tray bottom structure	131.5	-9.6
Bottom panel	118.6	-13.9
Circuit boards <sup>3</sup>	115.6	-13.9
Inner cover	114.1	-12.0
Thermal cover	80.4	-54.1

<sup>1</sup>See Ref. 7

<sup>2</sup>See Ref. 8

<sup>3</sup>Temperatures are averages for all circuit boards. Maximum difference between the temperature of any board and the average was less than 2°F.

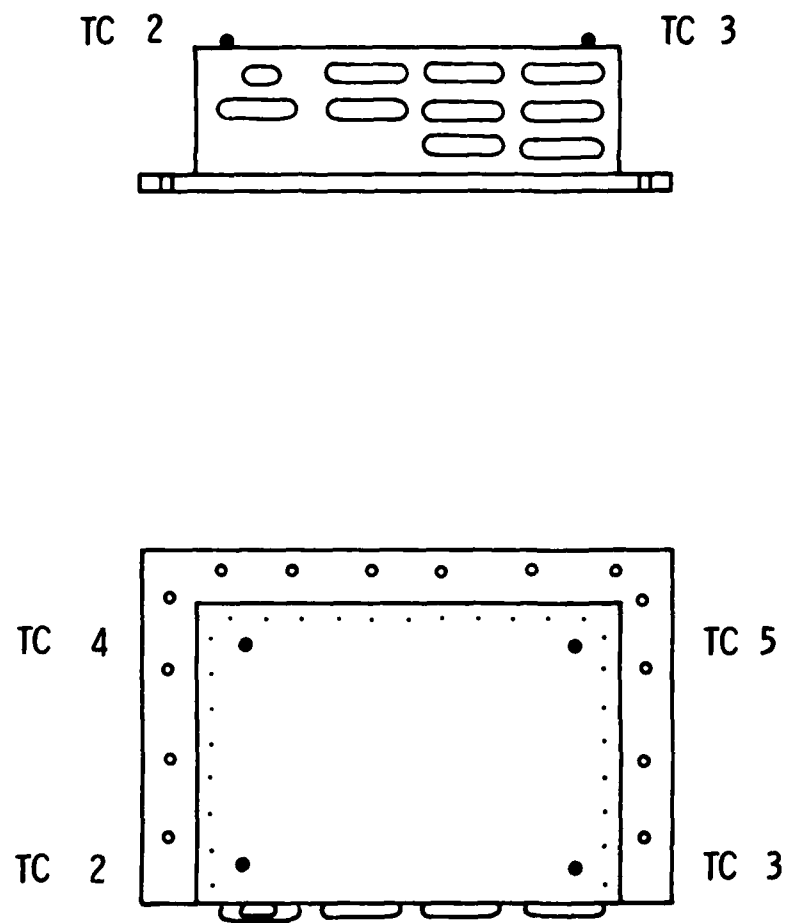


Fig. 19. Thermocouple Placement

Each SCU was subjected to seven temperature cycles. One cycle was defined as room temperature to elevated temperature returning to room temperature, then the remaining half cycle defined as room temperature to low temperature returning to room temperature (see Fig. 20). Each temperature cycle lasted approximately 11 hours, therefore, the seven cycle test was conducted in half-cycle increments. Electrical performance data were recorded at each temperature extreme and room temperature transition. Data were recorded only when the internally mounted thermistors V TEMP 1 and V TEMP 2 were within  $\pm 2.8^{\circ}\text{C}$  of the externally mounted thermocouples, TC 2,3,4, and 5. Heating and cooling of the SCU was achieved by controlling the temperature of a thermal shroud that surrounded the SCU. The ratio of thermal shroud surface area to the SCU surface area was approximately 5.7:1. Heating and cooling response curves that show the thermal relationship between the internal operational amplifier thermal heat sink to that of the SCU external surface and shroud temperatures are presented in Figs. 21 and 22.

#### C. EQUIPMENT DESCRIPTION

##### 1. GROUND SUPPORT ELECTRICAL EQUIPMENT

Ground support electrical equipment used to test the performance of the SCUs during the thermal-vacuum test included: (1) a pulse command sequencer, (2) transducer load simulator, (3) channel selector probe, and (4) a power supply. Figure 23 provides an overview of the SCU box level interconnections.

##### 2. THERMAL VACUUM TEST EQUIPMENT

The thermal vacuum test was conducted within a BEMCO Model A6H-60/90C-4M Space Simulator. This space simulator consists of a stainless steel vacuum vessel, thermal shroud, trichloroethylene brine circulating system, cascade mechanical refrigeration system for brine cooling, electric heat for brine heating, Honeywell Dialapak temperature control system for brine temperature control from  $-60$  to  $+90^{\circ}\text{C}$ , a vacuum system comprised of mechanical roughing and oil diffusion pumping, and a cold trap and vacuum instrumentation.

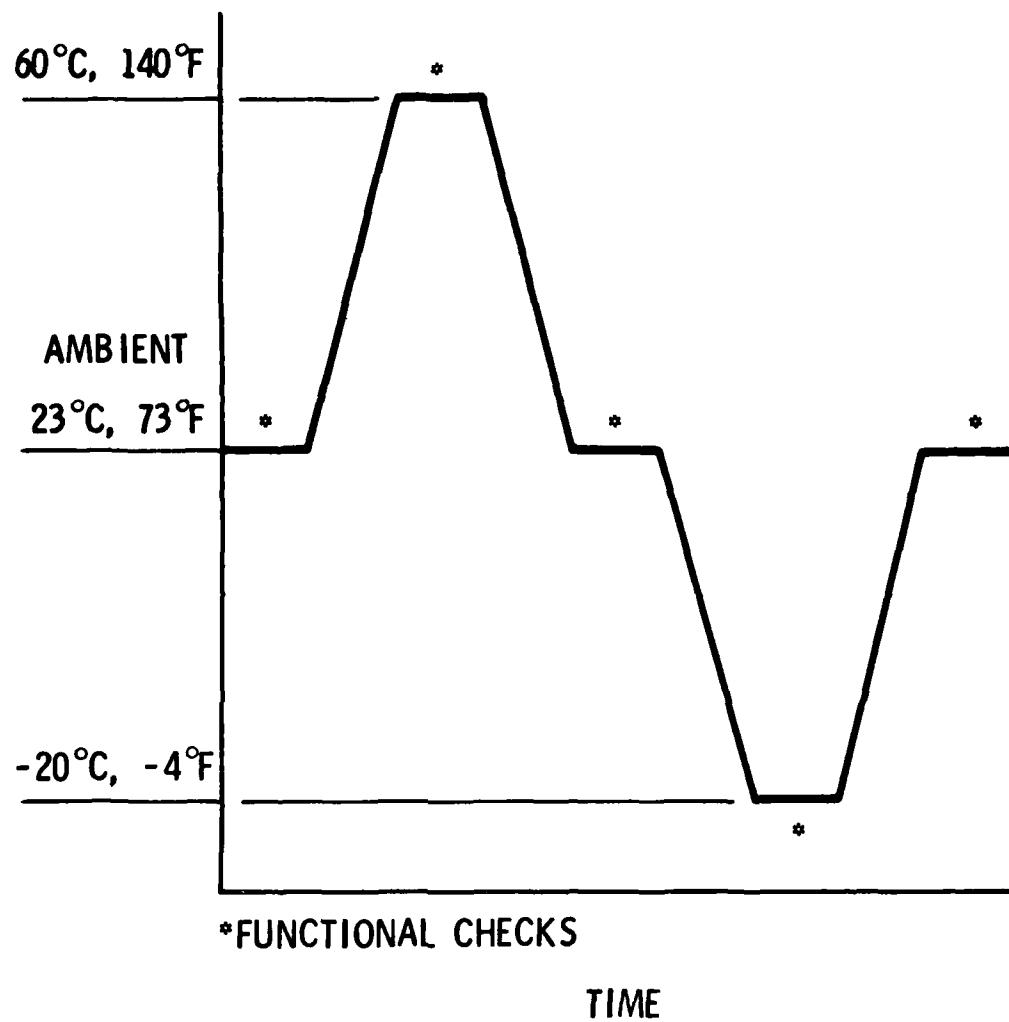


Fig. 20. Nominal Temperature Cycle

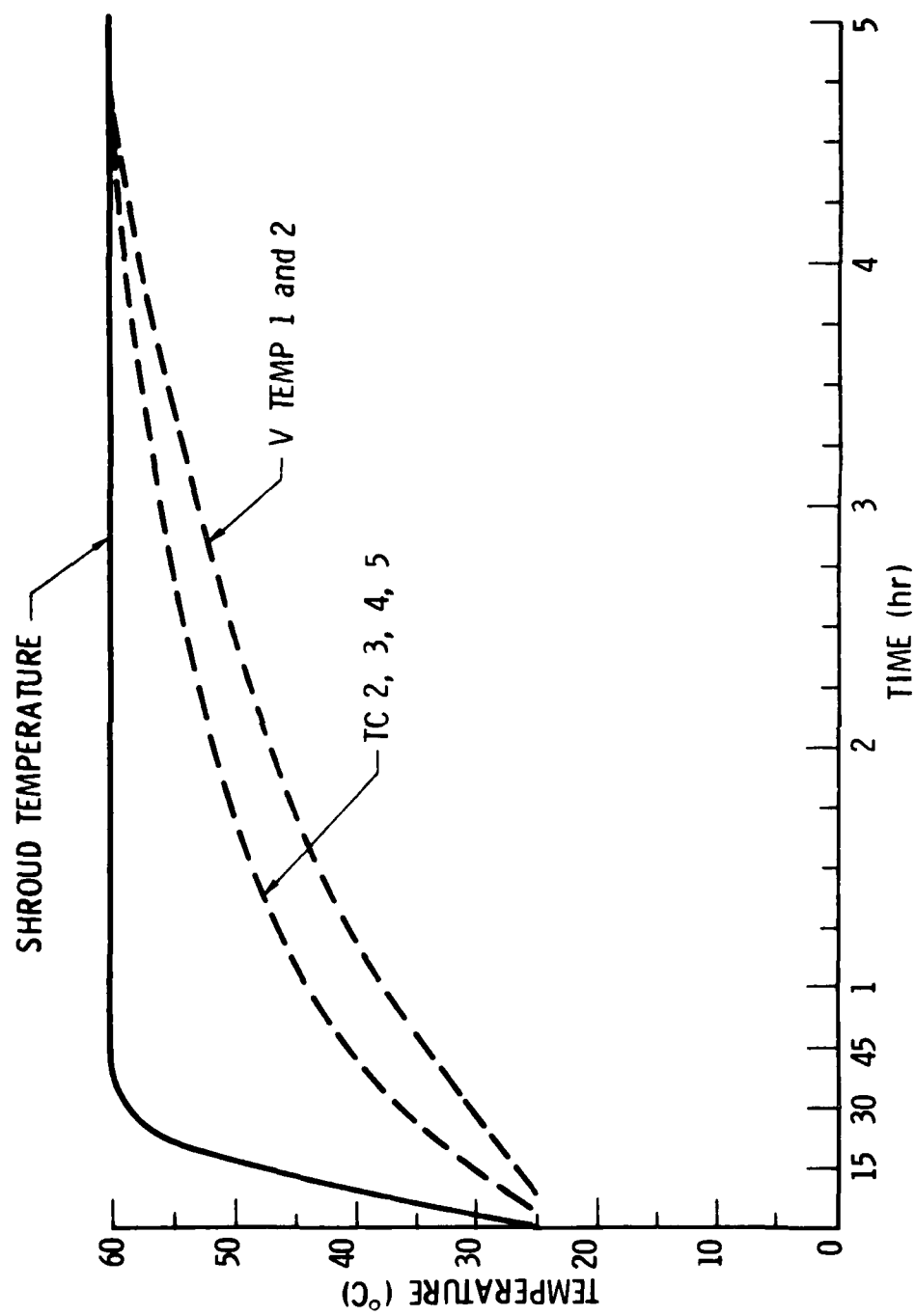


Fig. 21. Heat Cycle Response

# COOLING CYCLE RESPONSE

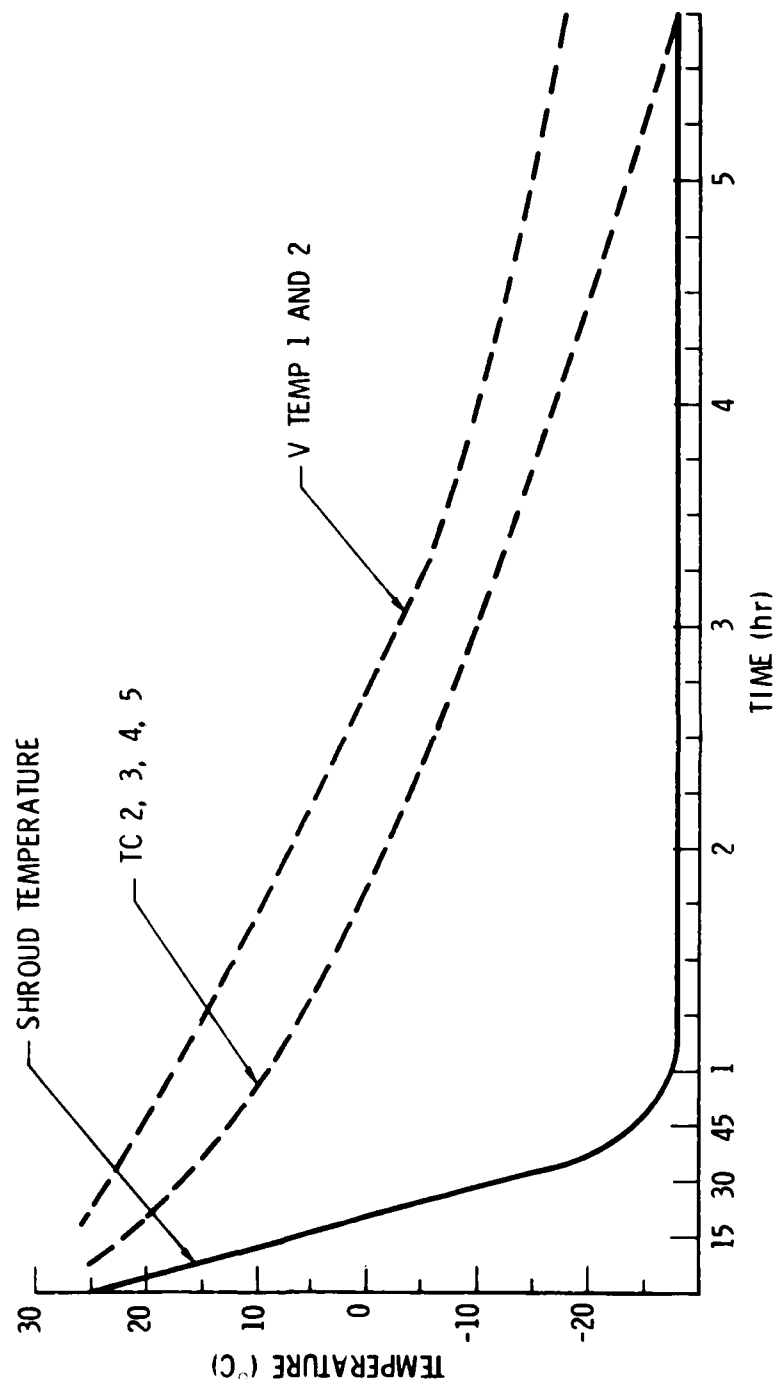


Fig. 22. Cooling Cycle Response

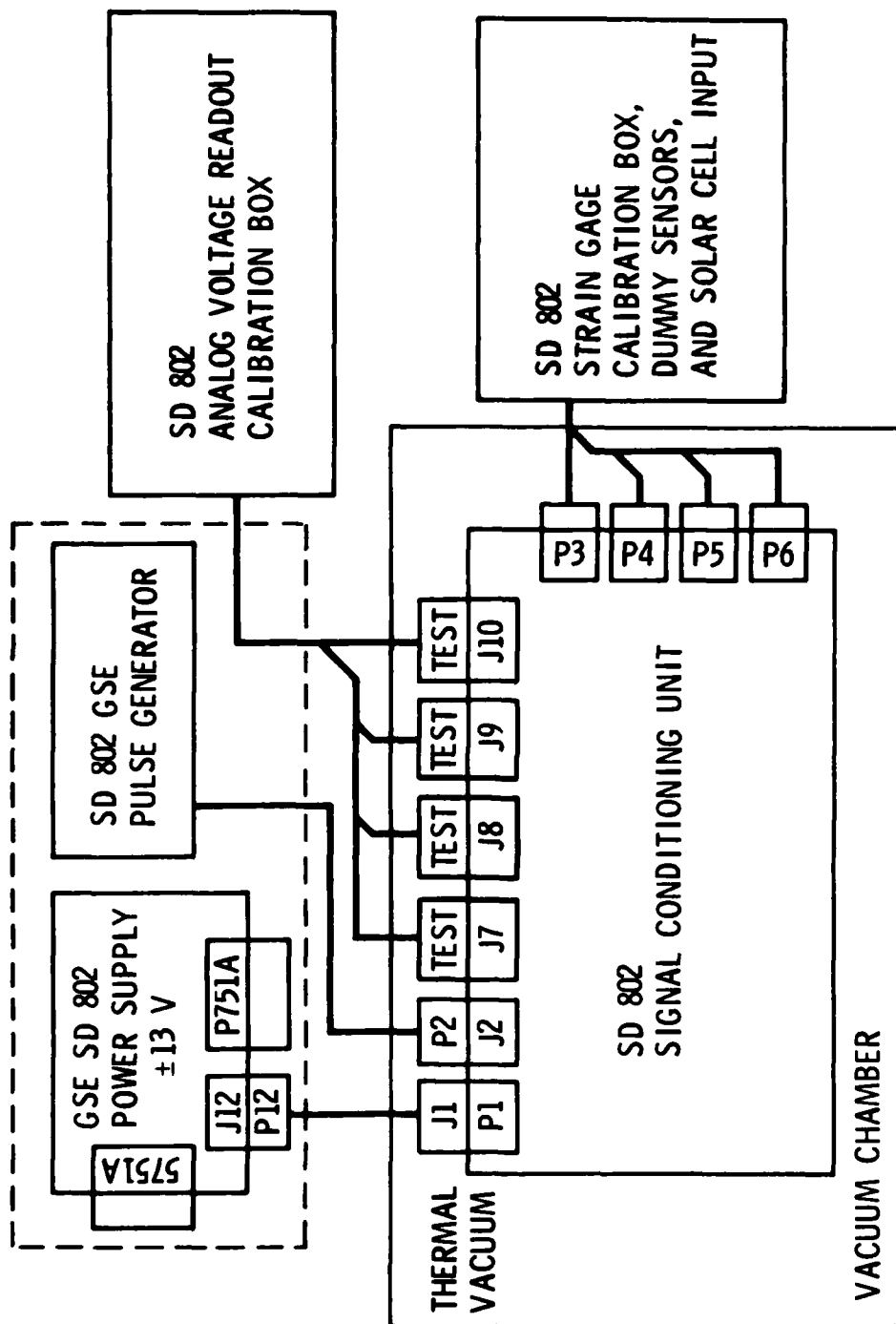


Fig. 23. Signal Conditioning Unit Box Level Test Interconnections

#### D. TEST RESULTS

##### 1. SCUs NO. 1 AND NO. 2 THERMAL VACUUM TEST RESULTS

Thermal vacuum tests on SCU No's. 1 and 2 have been completed. No physical defects were noted on either unit as a result of the test. No electrical failures, malfunctions, or out of tolerance conditions were noted on either unit as a result of the test.

Since this test was to qualify the SCU packages only, all data channels associated with transducers were energized using a fixed stable resistor as a load; this load resistor was located external to the temperature vacuum chamber, thus establishing that any change from a room temperature measurement originated from signal deviation in the signal conditioning unit as a result of thermal cycling. Simulated load values are shown in Table 2.

##### 2. DATA FORMAT

Data from the experiment are a mix of high level analog, low level analog, and parallel digital signals. The data processor and controller assembly will accept and process data from the SCU with a resolution equivalent to 1 in 1024 (10-bit words) or 0.1% of full range. Analog data collected during flight are converted to 10-bit digital words and stored on magnetic tape. The resolution of the low-level analog channels, -10 to +10 mV, is therefore 0.02 mV, and the resolution of the high-level channels, -5 to +5 volts full scale, is 10 mV.

##### 3. DATA PROCESSING

A representative sample of high level analog test data is shown in Table 3. These data represent channels 16 through 46 thermistor measurements. Table 4 is a summary of the typical variations in SCU output signals, for a constant transducer input, for strain gage and thermistor data channels. The maximum and minimum values represent the range of values (reproducibility) obtained during the course of the thermal-vacuum tests at a given temperature. The differences over the temperature range represent the temperature sensitivity of the signal conditioning circuits. For the thermistor data channels, both the reproducibility, at a given temperature, and the temperature



Table 2. Signal Conditioning Unit, Simulated Load Values

Transducer	Dummy Load	Data Simulated
Wide range thermistors	10 k $\Omega$ 1%	25°C
Composite thermistors	15 k $\Omega$	15°C
Low range thermistors	300 k $\Omega$	-59°C
High range thermistors	10 k $\Omega$	+52°C
Strain gage	1 k $\Omega$ ( $\pm 0.02\%$ at 25°C)	0 $\mu$ strain at 25°C
	1 k $\Omega$ shunted with 999 k $\Omega$	500 $\mu$ strain
	1 k $\Omega$ shunted with 499.5 k $\Omega$	1000 $\mu$ strain
	1 k $\Omega$ shunted with 333 k $\Omega$	1500 $\mu$ strain
	1 k $\Omega$ shunted with 249 k $\Omega$	2000 $\mu$ strain
Solar cell	160 mA	One sun
Fiber optic digital	+5 V	Logic high
Quartz crystal monitor	+5 V	Logic high

Table 3. Signal Deviation, Thermistor Data Channels

Data Channel	Simulated Signal Type	Leading Edge, SCU No. 1			Trailing Edge, SCU No. 2		
		Test Temperature (°C)			Test Temperature (°C)		
		-20	+25	+60	-20	+25	+60
		Output Signal (V)			Output Signal (V)		
16	Wide range thermistors	2.004	2.006	2.008	1.999	2.000	2.003
17	Wide range thermistors	2.001	2.003	2.005	1.997	1.999	2.001
18	Wide range thermistors	2.004	2.007	2.009	2.001	2.003	2.006
19	Wide range thermistors	2.004	2.006	2.008	2.001	2.003	2.006
20	Low range thermistors	0.452	0.452	0.452	0.456	0.456	0.456
21	Low range thermistors	0.450	0.452	0.452	0.452	0.452	0.452
22	Low range thermistors	0.453	0.453	0.453	0.451	0.452	0.452
23	Low range thermistors	0.451	0.452	0.452	0.453	0.453	0.453
24	Low range thermistors	0.451	0.451	0.451	0.450	0.453	0.450
25	Low range thermistors	0.451	0.451	0.451	0.452	0.450	0.452
26	High range thermistors	2.495	2.503	2.508	2.499	2.496	2.500
27	High range thermistors	2.494	2.501	2.506	2.500	2.497	2.501
28	High range thermistors	2.493	2.501	2.506	2.499	2.496	2.500
29	High range thermistors	2.495	2.502	2.508	2.499	2.496	2.500
30	High range thermistors	2.495	2.502	2.508	2.497	2.494	2.498
31	High range thermistors	2.495	2.503	2.508	2.499	2.496	2.500
32	Wide range thermistors	1.662	1.668	1.672	1.662	1.665	1.668
33	Wide range thermistors	1.659	1.663	1.666	1.659	1.662	1.665
34	Wide range thermistors	1.654	1.660	1.665	1.660	1.663	1.666
35	Wide range thermistors	1.661	1.666	1.669	1.660	1.662	1.665
36	Wide range thermistors	1.661	1.665	1.669	1.660	1.664	1.666
37	Wide range thermistors	1.661	1.665	1.669	1.663	1.666	1.669
38	Wide range thermistors	1.656	1.661	1.664	1.658	1.661	1.664
39	Wide range thermistors	1.657	1.662	1.665	1.657	1.660	1.663
40	Wide range thermistors	1.664	1.659	1.662	1.653	1.656	1.659
41	Wide range thermistors	1.663	1.668	1.671	1.662	1.665	1.668
42	Wide range thermistors	2.988	2.997	3.003	2.988	2.994	2.999
43	Wide range thermistors	2.989	2.997	3.003	2.987	2.994	2.999
44	Wide range thermistors	1.661	1.666	1.669	1.659	1.662	1.665
45	Wide range thermistors	1.660	1.665	1.668	1.659	1.662	1.665
46	Wide range thermistors	1.660	1.665	1.668	1.660	1.663	1.666
47		--	--	--	1.661	1.665	1.668

Table 4. Voltage Deviation, High Level Analog Data

Strain Gage, Analog Recording Channel No. 45		Temperature (°C)		
		-20	+25	+60
Signal Conditioning Unit No. 1, Maximum Voltage		0.125	-0.028	-0.118
Signal Conditioning Unit No. 1, Minimum Voltage		<u>0.095</u>	<u>-0.017</u>	<u>-0.093</u>
		0.030	-0.011	-0.015
Signal Conditioning Unit No. 2, Maximum Voltage		0.059	-0.029	-0.018
Signal Conditioning Unit No. 2, Minimum Voltage		<u>0.057</u>	<u>-0.019</u>	<u>-0.014</u>
		0.002	-0.010	-0.004
High Temperature Thermistor, Analog Channel No. 20				
Signal Conditioning, Unit No. 1, Maximum Voltage		2.495	2.503	2.508
Signal Conditioning, Unit No. 1, Minimum Voltage		<u>2.494</u>	<u>2.503</u>	<u>2.507</u>
		0.001	0.000	0.001
Signal Conditioning Unit No. 2, Maximum Voltage		2.494	2.501	2.500
Signal Conditioning Unit No. 2, Minimum Voltage		<u>2.494</u>	<u>2.496</u>	<u>2.498</u>
		0.000	0.005	0.000

sensitivity, over the full temperature range, are less than the resolution provided by a 10-bit word. For strain gage channels, the reproducibility is in the range of 1 to 3 times the resolution. The temperature sensitivity of these data channels is large, therefore sufficient data were collected to provide calibration of these channels as described in Section III.D.4.

The low level analog channels are dedicated to monitoring solar module output voltage. Output voltage is developed across a 0.05 ohm, 0.05% wire wound resistor; there was no noticeable voltage change during the temperature cycle test.

#### 4. STRAIN GAGE DATA CHANNEL CALIBRATION

Each group of 10 strain gage operational amplifiers shares a common heat sink, as noted in Section III.B. The temperature of each heat sink is monitored by a thermistor. The output of each amplifier over the temperature range from -2 to 60°C was recorded during the SCU thermal-vacuum tests.

Three representative curves of amplifier output versus temperature are shown in Fig. 24, 25, and 26. In these figures output voltages have been converted to apparent strain values ( $1 \text{ mV} = 1 \mu\epsilon$ ). Such curves for each strain gage amplifier will be used to correct the flight data for the temperature sensitivity of the amplifiers.

#### 5. SCU OPERATIONAL PERFORMANCE

A summary of the allowable range for key operational parameters compared to values of these parameters measured during the thermal-vacuum tests is shown in Tables 5 and 6. The stated input voltage requirement is based on the range over which proper regulation is provided by the 5V power supply regulators. The anticipated output voltages of the flight batteries falls within this range at all temperatures. The voltages used during actual measurements were selected to represent the range of voltage required for proper regulation. The actual voltages were provided by a variable voltage power supply. All parameters were within the allowable range at all temperatures.

○ SCU No. 2, CYCLE 7  
 △ SCU No. 2, CYCLE 6  
 × SCU No. 2, MISC.  
 I THERMAL SENSITIVITY

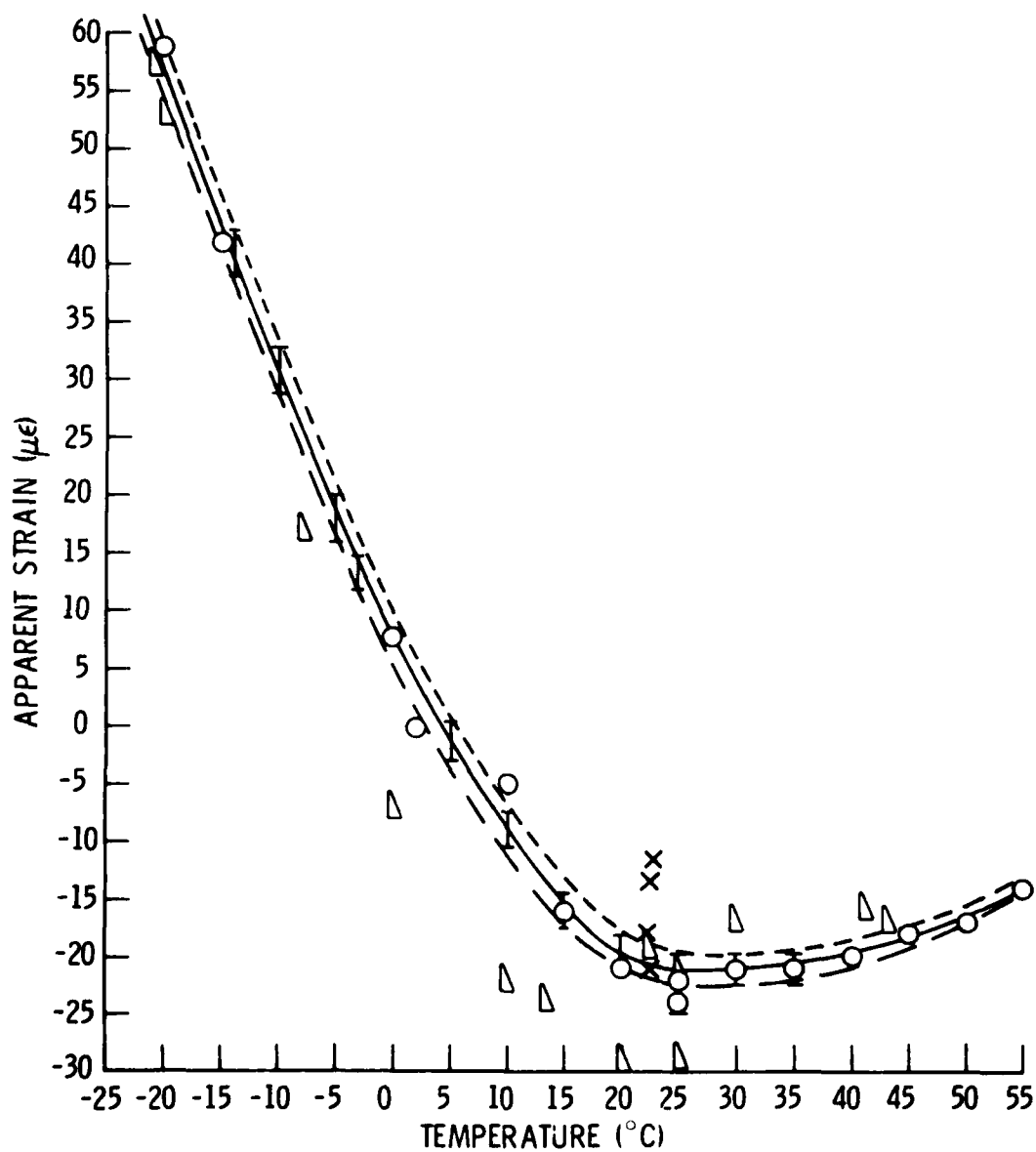


Fig. 24. Temperature Dependence of Apparent Strain SCU No. 2, Amplifier No. 1

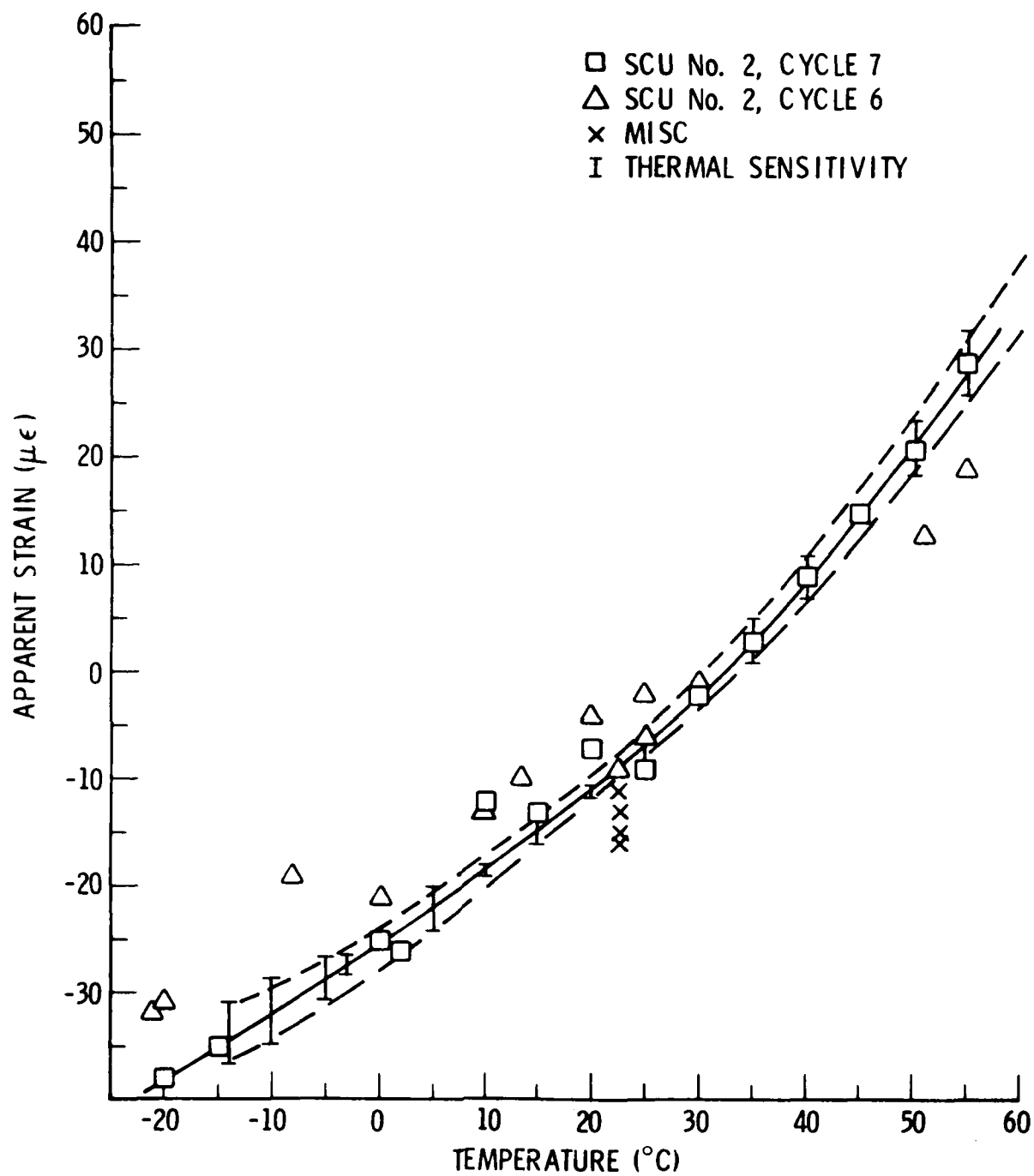


Fig 25. Temperature Dependence of Apparent Strain SCU No. 2, Amplifier No. 2

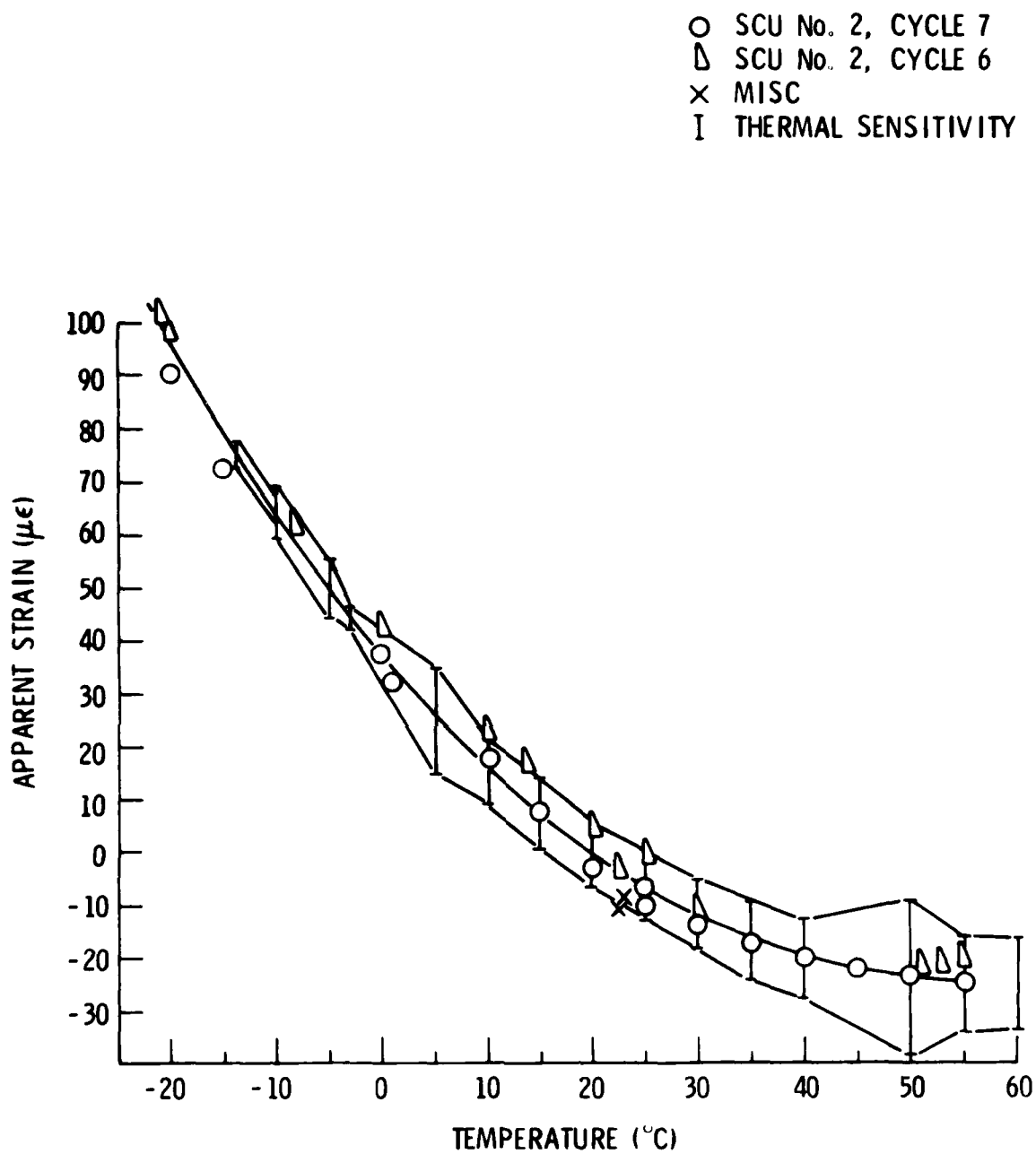


Fig. 26. Temperature Dependence of Apparent Strain SCU No. 2, Amplifier No. 4

Table 5. Signal Conditioning Unit Functional Limits for SCU, S/N 1

Parameter	Requirement		Actual Measurements		
	Minimum	Maximum	-20°C	25°C	+60°C
Input voltage (positive)	+10.5 V	+15.1 V	13.1 V	13.1 V	13.1 V
Input voltage (negative)	-10.5 V	-15.1 V	-13.1 V	-13.1 V	-13.1 V
Positive input power standby	0	200 mA	160 mA	160 mA	160 mA
	0	0.4 mA	0.270 mA	0.270 mA	0.270 mA
Negative input power standby	0	200 mA	130 mA	130 mA	130 mA
	0	0	0	0	0
+5 V I regulator	4.95 V	5.05 V	4.998 V	5.005 V	5.008 V
+5 V II regulator	4.95 V	5.05 V	4.999 V	5.003 V	5.006 V
-5 V III regulator	-4.90 V	-5.10 V	-5.048 V	-5.055 V	-5.060 V
Decision enable pulse	15 msec	40 msec		EPDS (time)	
Decision disable pulse	15 msec	40 msec		EPDS (time)	
Power up time (KI relay on)					
Self abort	30 sec	80 sec	38 sec	40 sec	44 sec
EPDS disable			20 sec	22 sec	22 sec
Decision level high	7.0 V	8.4 V	7.8 V	7.8 V	7.8 V
Warmup time before decision pulse	20 sec	30 sec	20 sec	22 sec	22 sec
Decision-disable pulse width for K2 relay activation	10 msec				
Enable level	4.5 V	8.5 V		30 msec	
Enable pulse delay determined by EPDS time listed as msec and sec are approximate				EPDS (battery)	



Table 6. Signal Conditioning Unit Functional Limits for SCU, S/N 2

Parameter	Requirements		Actual Measurements		
	Minimum	Maximum	-20°C	+25°C	+60°C
Input voltage (positive)	+10.5 V	+15.1 V	+10.5 V	+13.1 V	+15.1 V
Input voltage (negative)	-10.5 V	-15.1 V	-10.5 V	13.1 V	-15.1 V
Positive input power standby	0	200 mA	160 mA	160 mA	160 mA
	0	0.40 mA	0.145 mA	0.270 mA	0.370 mA
Negative input power standby	0	200 mA	130 mA	130 mA	130 mA
	0	0	0	0	0
+5 V I regulator	4.95 V	5.05 V	5.00 V	5.005 V	5.007 V
+5 V II regulator	4.95 V	5.05 V	5.00 V	5.003 V	5.005 V
-5 V III regulator	-4.90 V	-5.10 V	5.05 V	-5.055 V	-5.05 V
Decision enable pulse	15 msec	40 msec		EPDS (time)	
Decision disable pulse	15 msec	40 msec		EPDS (time)	
Power up time (K1 relay on) Self abort EPDS disable	30 sec	80 sec	40 sec	40 sec	40 sec
			22 sec	22 sec	22 sec
Decision level high	7.0 V	8.4 V	7.85 V	7.85 V	7.85 V
Warmup time before decision pulse	20 sec	30 sec	22 sec	22 sec	22 sec
Decision-disable pulse width for K2 relay activation	10 msec			30 msec	
Enable level	4.5 V	8.5 V		EPDS (battery)	
Enable pulse delay determined by EPDS time listed as msec and sec are approximate					

#### IV. DISPOSITION OF TEST ANOMALY

##### A. FAILURE MODE, SIGNAL CONDITIONING UNIT, SN 001

The posttest electrical performance test revealed one broken wire at connector J-10, pin No. 17. The inoperative circuit was analog channel No. 9, which was used to monitor the voltage input to the data processor controller assembly.

##### B. CORRECTIVE ACTION

Lacing on the wire bundle entering connector J-10 was removed, and the defective solder joint was repaired and inspected by the laboratory quality control inspector. The wire bundle was secured, and electrical performance tests were conducted. All data recorded was comparable to the recorded pretest data.

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#### LABORATORY OPERATIONS

The Laboratory Operations of The Aerospace Corporation is conducting experimental and theoretical investigations necessary for the evaluation and application of scientific advances to new military space systems. Versatility and flexibility have been developed to a high degree by the laboratory personnel in dealing with the many problems encountered in the nation's rapidly developing space systems. Expertise in the latest scientific developments is vital to the accomplishment of tasks related to these problems. The laboratories that contribute to this research are:

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